PATENT SPECIFICATION

DRAWINGS ATTACHED

1,005,448

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COMPLETE SPECIFICATION

Abrasive Articles and Methods of Making the Same

We, REXALL DRUG AND CHEMICAL COMPANY, a Corporation organised under the laws of the State of Delaware, United States of America, of 8480 Beverly Boulevard, Los Angeles, in the County of Los Angeles, and State of California, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described, in and by the following statement:—

THIS INVENTION RELATES TO the manufacture of abrasive products.

There has been a long-standing and insistent demand and need for abrasive products embodying certain specific, highly desirable qualities. The primary qualities are listed as follows:—

1. Free-cutting abrasive action.
2. Controlled flexibility.
3. Multiple grain thickness of abrading component.
4. High strength with accompanying high speed safety factor.
5. Resilient or cushioned action comparable to the effect of a built-in shock absorbing media.
6. Controlled intermittent cutting action similar to saw-tooth cutting action.
7. Thorough and effective utilisation of the abrasive material.
8. Extraordinarily long life of the abrasive product.

The prior art has offered many different forms of abrasive products, each of which has provided one or more of these qualities to some degree but always at a sacrifice of one or more of the other equally desirable qualities or features. For example, a conventional coated abrasive belt or disc has a high degree of flexibility and free-cutting action but is of inordinately short life because of the limitation of the abrasive coating to substantially a single grit size in thickness. Again, ordinary rigid bonded grinding wheels, although stronger and of much longer life than conventional coated abrasive products, lack the flexibility and much of the versatility offered by the latter type of product. Efforts heretofore to provide a single article offering these various characteristics or qualities have met with little or no success.

It is therefore an object of the present invention to provide an abrasive product that can be made in flexible form such as in the form of a belt, disc or other shape, but is not restricted to a single layer of abrasive grains substantially one grit size thick and which will have much longer life.

According to the present invention there is provided an abrasive article comprising a multiplicity of small, isolated, rigidly-bonded abrasive bodies secured in a bonded abrasive-containing matrix of a permanently resilient, thermoplastic resin.

According to a further aspect of the present invention there is provided a method of making a flexible abrasive article having a functional surface of substantial depth comprising forming an abrasive-containing fibrous matrix bonded by a thermoplastic resin, forming tapered cavities in said matrix, loading said cavities with abrasive granules and a heat-hardenable resin bond, and subjecting the matrix to heat and pressure to harden the resin bond and mature the thermoplastic resin of the matrix.

The present invention is based on the mechanical concept of fabricating an abrasive article of a predetermined number of individual small strongly or rigidly bonded abrasive bodies, appropriately designated herein as abrasive micro segments or micro segmental bodies, each of these small abrasive bodies positioned into a pattern for effective abrading and yet yieldably supported so as to have a controlled mobility whereby fresh cutting facets of the abrasive micro segments are

[Price 4s. 6d.]

constantly presented at the abrading face of the article. Furthermore, the resulting abrasive article may be of over-all flexible character, despite the fact that the abrading component is of substantial thickness. These objectives have been accomplished by forming an abrasive article from a multiplicity of individual rigidly bonded abrasive bodies mounted or supported in a surrounding resilient matrix or reticulum which may be flexible in, such a way that the rigid abrasive bodies can be described as being hinged to the ribs of the reticulum. The reticulum is also abrasive in character, and preferably reinforced by a network of filamentary material. The resulting abrasive component made up of the abrasive bodies and surrounding reticulum may be suitably mounted or secured upon a backing or support to form the desired article, such as an abrasive belt or disc, grinding wheel, set-up wheel, polishing wheel or other shape. According to another modification of the invention, the abrasive reticulum bearing the positionised micro segments is applied to one or both lateral faces of a grinding wheel, such as a cutting off wheel, or to the one side of a depressed centre disc wheel, to impart an abrasive surface of patterned roughness.

In order that the invention may be more clearly understood, reference is made to the various figures of the accompanying drawings, in which:—

Figure 1 is a top plan view of an abrasive disc made in accordance with the present invention;

Figure 2 is a cross sectional view through the line 2—2 of Figure 1;

Figure 3 is a view similar to that of Figure 2 showing a modified form of flexible abrasive disc made in accordance with the present invention;

Figure 4 is a highly enlarged fragmentary cross-sectional view of the annular portion of the abrasive disc of Figure 3;

Figure 5 is a bottom plan view of one form of reticulum used in making abrasive articles in accordance with the present invention, the view showing the reticulum as filled with the micro segmental abrasive bodies;

Figure 6 is a sectional view through a fragment of Figure 5;

Figure 7 is a perspective view of an abrasive belt made according to the present invention; and

Figure 8 is an enlarged sectional view of an abrasive cutting-off wheel embodying certain features of the present invention.

The abrasive articles of the present invention, irrespective of the specific form in which they are made, can be briefly described as consisting of two components, namely (a) a plurality of rigidly bonded small abrasive bodies herein designated as abrasive micro segments or micro segmental abrasive bodies, (b) a resilient abrasive-bearing means or reticulum, preferably provided with filamentary reinforcing elements, for retaining the small abrasive micro segments in position for effective cutting action and providing them with a resilient cushioned supporting medium as well as supplementing their abrasive action. The abrasive-bearing means or reticulum may also serve as a means for mounting or attaching the abrading component to a suitable support or backing, and may be of a flexible nature.

The abrasive micro segments are composed of abrasive grains of any desired grit or particle size or sizes and a heat-hardened organic bond such as a heat-hardened phenol formaldehyde resinous condensation product or a vulcanised hard rubber, together with other auxiliary ingredients such as catalysts, vulcanisers, accelerators, or fillers to obtain the desired catalytic action, accompanied by vulcanisation and/or polymerisation under the proper selected conditions of time, temperature and pressure. Suitable compositions for making resin-bonded and rubber-bonded abrasive bodies are too well known to require detailed formulation and description herein, having been disclosed in numerous prior art patents and in the literature. For example the following patents disclose compositions for making resin-bonded abrasive bodies suitable for use in carrying out the present invention:

British Patent No. 225,436
British Patent No. 431,062
British Patent No. 333,409
British Patent No. 467,434
U.S. Patent No. 2,171,635 to Robie et al.

Similarly, British Patent No. 311,104 discloses compositions that can be used to make rubber-bonded abrasive bodies. Having prepared a distributable mass of abrasive grains and organic resinous or rubber heat-hardenable bond of the selected composition, the individual small abrasive bodies or micro segments are formed and positioned in the supporting matrix or reticulum in the manner described later herein. As pointed out below, the individual abrasive micro segments are preferably given a tapered conformation such as that of a four-sided pyramid in order to provide additional means for securing them against dislodgement during use of the abrasive article.

An abrasive-bearing matrix or reticulum that has been found satisfactory as the carrier means and supporting medium for the individual abrasive micro segments described above can be made as follows. Using the process described in British Patent No. 557,038, an abrasive-included fibrous web is formed embodying a permanently thermoplastic resinous polymerisation products as the interstitial bonding medium for the interlocked textile fibres and abrasive granules. It is essential for purposes of the present invention that the bonding constituent of the

fibrous web be of permanently tough resilient character.

We have found that the thermoplastic resinous polymers, copolymers and heterpolymers of acrylic acids, such as the low and high acrylic esters of acrylic and methacrylic acids are highly satisfactory as the thermoplastic resinous binder of the reticulum or matrix. Among those acrylic polymers which can be used are polymerised methyl acrylate, ethyl acrylate, methyl methacrylate, polymerised methacrylic acid, butyl methacrylates, propyl methacrylates, both polymerised and copolymerised with one another. Furthermore, any degree of flexibility and toughness in the thermoplastic resinous matrix can be obtained by blends of the various acrylic or acrylate polymers, or by the use of various plasticisers with the basic polymer. These acrylic resins are compatible with most classes of plasticisers including phthalates, tartrates, phosphates, and adipates. The general physical properties of various acrylic resinous materials and how they can be varied by the selection of the correct ester or blend of esters, with or without plasticisers or other modifiers are fully set forth in the literature and in many issued patents.

While we have pointed out above how various acrylic polymers of suitable toughness and flexibility can be used as the binder of the matrix or reticulum for securing the abrasive micro segments together in articles made according to the present invention, other thermoplastic resinous materials comparable to the acrylic resins in these properties can be similarly used.

After the abrasive-containing fibrous web of thermoplastic material has been formed it is subjected to a moulding operation, such as by passing it through a set of configurated rollers or subjecting it to pressure between mould plates of suitable design to form in the material a multiplicity of small cavities or pockets, preferably of tapered configuration, extending in from one side of the fibrous web or sheet. When the abrasive-included fibrous sheet of thermoplastic material is reinforced with a network of filamentary strands such as nylon or glass fibre strands, the moulding operation is carried out so that the pockets or cavities formed in the material are in register with the interstices formed by the network of reinforcing filaments. During the formation of the abrasive-included fibrous sheet material a reinforcing network of filamentary strands of nylon, glass yarn or other reinforcements is incorporated into the structure. The moulded sheet material is then cut into the desired size and shape for making abrasive articles of the selected form and type. For example, if abrasive discs are to be made the sheet material is cut out in the form of discs of a diameter equal to the diameter of the abrasive disc to be made.

After the abrasive grain-resin bond composition has been prepared in sufficient quantity, and the moulded abrasive-bearing thermoplastic resin sheet material has been fabricated and cut to size, the abrasive article is assembled and formed as follows. A layer of the moulded thermoplastic resinous sheet material is placed upon the bottom plate of a mould with the cavities of the moulded sheet material facing upwardly. The abrasive grain-resin bond composition is then placed upon the sheet material and distributed thereover to fill each of the individual patternised cavities thereof. The flexible backing material, cut to the same size and shape as the moulded abrasive-containing reticulum, is placed over the abrasive filled thermoplastic matrix or reticulum, the top mould plate placed over the assembled materials and the entire assembly subjected to heat and pressure for a sufficient period of time to polymerise or vulcanise the resin or other organic bond of the abrasive segments, mature the thermoplastic resin of the reticulum and combine the backing and the abrasive-filled reticulum and form the resultant abrasive article.

Any suitable flexible material can be used as the backing such as one or more layers of latex-filled fabric, canvas, drills, or other suitable flexible materials, the fibres of any of said fabrics being any material or synthetic, organic or inorganic textile fibrous material, such as and including glass or ceramic fibres, nylon or other polyamide fibres, polyester fibres, and re-generated cellulose (rayon) fibres, singly or in blends.

Referring further to the drawings, Figures 1 and 2 illustrate an abrasive disc made in accordance with the teachings of the present invention. The flexible disc 10 as shown is 7″ in diameter with a 1″ central mounting arbor 11. The disc comprises an abrasive layer 12 of substantial thickness bonded to a flexible backing consisting of two layers 13 and 14 of latex-impregnated burlap or osnaburg cloth. The abrading component 12 of the disc is constructed of an abrasive-bearing thermoplastic resilient fibrous cushioning matrix 15 provided with a multiplicity of small cavities 16 filled with micro segments 17 of resin bonded abrasive material. The abrasive micro segments 17 are tapered on four sides and are generally pyramidal in shape with the base of the pyramids adjacent the flexible backing of the disc and the tips 18 extending through the fibrous matrix or reticulum 15. The abrasive surface of the disc, as shown in Figure 1, consists of a multiplicity of small rigid bonded abrasive bodies constituting the tips or uppermost portions of the individual abrasive micro segments 17 surrounded by the thermoplastic, abrasive containing matrix or reticulum 15. The result is the provision of an abrasive article having a functional surface made up

of a multiplicity of isolated small hard-bonded abrasive bodies surrounded and supported by a matrix or zone of softer, more resilient or yieldable material that is also abrasive in character.

Figures 3 and 4 show a modified form of abrasive disc, similar to that shown in Figures 1 and 2, but in which, in addition to the two layers of latex-impregnated fabric 20 and 21 and the primary abrasive layer 22 containing the abrasive micro segments 23 extending over the entire surface of the disc, there is provided a supplementary layer of fabric between the abrasive layer 22 and the uppermost layer 21 of the flexible backing. This secondary layer 24 is of heavy drill cloth in which the annular zone extending in a short distance from the periphery of the disc is moulded to form a number of pockets or cavities similar to those provided in the abrasive reticulum of the disc, the cavities being filled with abrasive micro segments similar to those of the primary abrasive layer 22 of the disc. This supplementary layer of abrasive micro segments about the periphery of the disc serves to extend the life of the disc by replacing the layer 22 as it becomes worn away.

Figures 5 and 6 depict the preferred type of filamentary reinforced thermoplastic matrix or reticulum in which a network of reinforcing yarns 27 is incorporated within the abrasive-charged fibrous thermoplastic resin reticulum at the time of its fabrication. It can be seen from the structural details of Figure 6 how the tapered sides of the micro segments 17 are held by the reinforcing filaments 27 against disruption in the course of grinding. The resilient cushioning action of the matrix or reticulum 15 permits of a controlled mobility of the individual segments 17 and at the same time the abrasive particles 28 contained in the matrix 15 retard the wearing away of the matrix or reticulum prematurely so that as a result the overall cutting action of the disc is rendered effective by reason of the saw-tooth cutting action stemming from the rigidly bonded individual abrasive bodies in conjunction with the abrasive action of the matrix.

Figure 7 depicts an endless abrasive belt 30 embodying the same structural features as the abrasive disc shown in Figures 1 and 2.

Figure 8 shows a resin-bonded cutting-off wheel comprising a resin-bonded abrasive body 31 having bonded to each of the lateral faces a single ply or layer 32. Each of the layers 32 is made up of an abrasive-containing fibrous thermoplastic resinous reticulum 33 containing a pattern of abrasive micro-segments 34. As a result the sides of the cutting-off wheel are provided in use with a roughened and patterned cutting face in which the abrasive is present in the outermost facets of the roughened surface.

Any of the abrasive materials in common use may be employed in practising the present invention. Such materials include silicon carbide, fused aluminium oxide grains, flint, natural corundum, emery, and zeolite. The size of the abrasive may vary from the finest polishing or buffing powders to the coarser grit sizes used in grinding.

WHAT WE CLAIM IS:—

1. An abrasive article comprising a multiplicity of small, isolated, rigidly-bonded abrasive bodies secured in a bonded abrasive-containing matrix of a permanently resilient, thermoplastic resin.

2. An abrasive article as claimed in claim 1, comprising a flexible backing to which the matrix is adhesively bonded, the matrix having a filamentary reticulum embedded therein.

3. An abrasive article as claimed in claim 1 or 2, in which the abrasive bodies are pyramidal in shape.

4. An abrasive article as claimed in claim 2 or 3, in which the abrasive bodies are held in the interstices of the reticulum with the tips extending thereabove.

5. An abrasive article as claimed in any preceding claim, in which the matrix is provided with a multiplicity of tapered cavities in which the abrasive bodies are located.

6. An abrasive article as claimed in any of claims 2 to 5, in which the filaments of the reticulum act to reinforce the abrasive bodies.

7. An abrasive article as claimed in any of claims 2 to 6 in which the matrix comprises a layer of fibrous material bonded by a thermoplastic resin.

8. An abrasive article as claimed in any preceding claim in which the matrix comprises a layer of interlocked fibres and an acrylic resinous polymerisation product.

9. An abrasive article as claimed in any of claims 2 to 8 in which the filaments of the reticulum are of glass fibre.

10. An abrasive article as claimed in any of claims 2 to 8, in which the filaments of the reticulum are of nylon fibre.

11. An abrasive article as claimed in any preceding claim, in which the article is formed as a layer and is secured to at least one lateral face of a body of organic bonded abrasive grain to form an abrasive wheel.

12. A method of making a flexible abrasive article having a functional surface of substantial depth comprising forming an abrasive-containing fibrous matrix bonded by a thermoplastic resin, forming tapered cavities in said matrix, loading said cavities with abrasive granules and a heat-hardenable resin bond, and subjecting the matrix to heat and pressure to harden the resin bond and mature the thermoplastic resin of the matrix.

13. A method of making a flexible abrasive article as claimed in claim 12, comprising placing the abrasive-charged matrix upon a flexible backing material which is united to

the matrix upon the application of heat and pressure.

14. A method of making a flexible abrasive article as claimed in claim 12 or 13, comprising reinforcing the matrix with a network of filamentary strands extending in a plurality of directions, and forming the tapered cavities in said matrix in the spaces formed by the network of filamentary strands thereof.

15. A method of making a flexible abrasive article as claimed in any of claims 12 to 14, in which the thermoplastic resin of the matrix is an acrylic polymer.

16. A method of making a flexible abrasive article as claimed in claim 14 or 15, in which the filamentary strands of the matrix are glass fibre yarn.

17. A method of making a flexible abrasive article as claimed in claim 14 or 15, in which the filamentary strands of the matrix are nylon yarn.

18. An abrasive article substantially as hereinbefore described with reference to the accompanying drawings.

19. A method of making a flexible abrasive article having a functional surface of substantial depth substantially as hereinbefore described with reference to the accompanying drawings.

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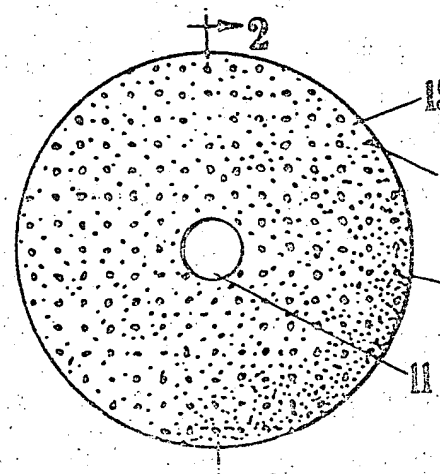

FIG. 1.

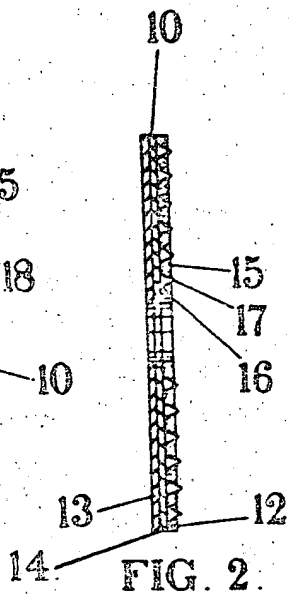

FIG. 2.

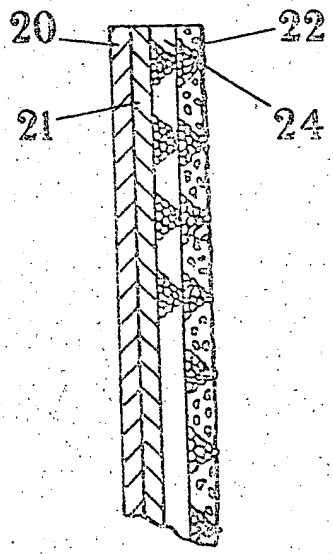

FIG. 3.

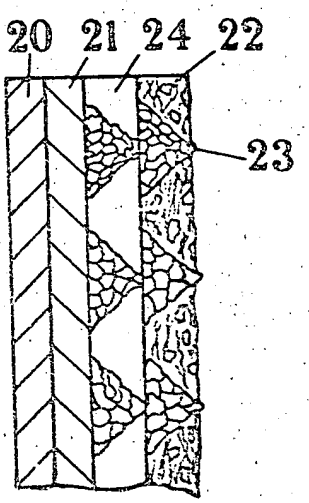

FIG. 4.

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Sheets 1 & 2

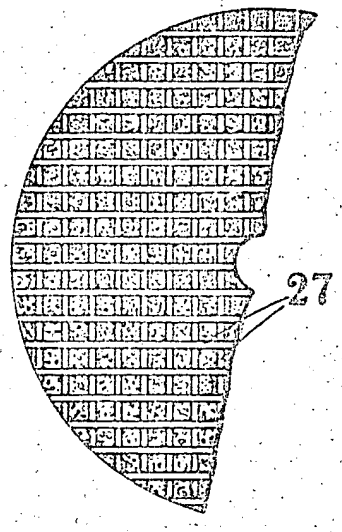

FIG. 5.

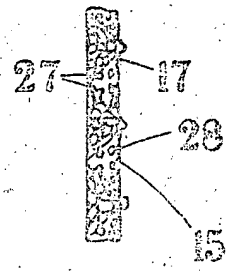

FIG. 6.

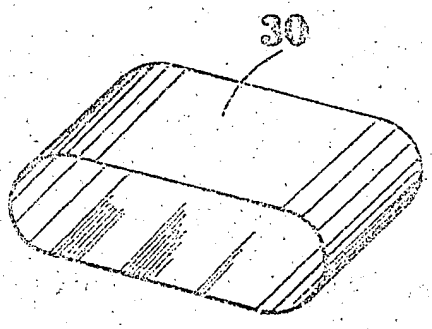

FIG. 7.

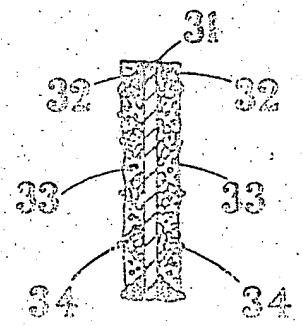

FIG. 8.